

EVALUATION OF SOME CHEMICAL AND CULTURAL ALTERNATIVES
TO METHYL BROMIDE FUMIGATION OF SOIL IN A CALIFORNIA
STRAWBERRY PRODUCTION SYSTEM

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The experiments reported here are part of a larger project supported by the California Strawberry Commission and ARS-USDA to research chemical and nonchemical alternatives to Methyl Bromide for preplant fumigation of soil in strawberry production. Chemical alternatives to Methyl Bromide were tested in two large field experiments near Watsonville, CA. Both fields had been fumigated previously prior to planting strawberries in a strawberry-vegetable rotation. In September, 1993, one field was cultivated flat, divided into three replicate blocks, and further divided for five preplant treatments of soil, i.e., fumigation with Methyl Bromide /Chloropicrin (67/33% @ 325 lb/acre), Chloropicrin (300 lb/acre), Telone II (1,3-Dichloropropene)/Chloropicrin (70/30% @ 454 lb/acre), Vapam (Metham-sodium, 100 gal/acre), or not treated. Fumigants were injected at 20 cm depth (broadcast treatment) and the soil was immediately covered with polyethylene tarpaulin. Vapam was sprayed onto the soil, rototilled, and covered with tarpaulin. Nontreated soil was not covered. Tarpaulin was removed after 5 days, beds were raised, and the strawberry cultivar Selva transplanted (2 rows/bed) on November 11, 1993, approximately 6 weeks after soil treatment. A repeat experiment was initiated in September, 1994, on a second field where the Vapam treatment was replaced with 30/70% Telone II/Chloropicrin @ 409 lb/acre. Conventional practices for strawberry production and pest management were followed, including sprinkler irrigation initially and drip irrigation at bed centers in the production season.

Total populations of fungi and bacteria in soil were estimated by dilution plating on three media. For the first 5 months after treatment, all chemicals used reduced total populations of fungi by 65-85% relative to populations in nontreated soil. Starting in May, 1994, populations of fungi in Vapam-treated soil increased, while the soil treated with other fumigants continued to have significantly lower populations of fungi. Total populations of bacteria were variable and were not generally reduced significantly by the chemical treatments used. Plant parasitic nematodes and Verticillium populations were measured separately and were low in all soil treatments.

The incidence of transplant failures was equally low in all soil treatments. Starting in late March, 1994, plant growth (measured as ground area covered) in Vapam-treated and nontreated soil was significantly less than in other treatments. All of the fumigants used in the repeat experiment (1994-95) increased growth significantly relative to that in nonfumigated soil. The incidence of plants with recognizable diseases (e.g., *Phytophthora* root and crown rots, *Verticillium* wilt, or collapse of unknown etiology) in all treatments was less than 1.2 and 4.0% in 1994 and 1995, respectively. Therefore, average growth and yield differences were due largely to overall differences in plant growth and vigor.

Berries were picked for fresh market at least twice weekly by normal grower practice starting April 1 and continuing into November. In 1994, yields for the Methyl Bromide /Chloropicrin, Chloropicrin, and Telone II /Chloropicrin treatments were nearly the same and were not significantly different at any time. In contrast, berry yields in Vapam-treated soil and nontreated soil were significantly (40-48%) less than in other treatments at all times after mid-April. However, berry size and the fraction of berries not meeting picking standards did not differ greatly between treatments. Increases in marketable yields to date in 1995, over that in nonfumigated soil, are approximately 50% for both Telone II/Chloropicrin treatments, 36% for Methyl Bromide/Chloropicrin, and 30% for Chloropicrin alone.

The results these two experiments suggest the following: 1) Methyl Bromide /Chloropicrin, Chloropicrin alone, and Telone II /Chloropicrin worked equally well on ground with a history of vegetable-strawberry rotation and fumigation; 2) Vapam did not improve growth or yield over that in nonfumigated soil, but the method of application was far from optimum; and 3) growth and yield responses to fumigation occurred in the absence of significant pressure from known diseases.

In a separate experiment at a field site near Watsonville, CA, where Verticillium populations are high, bed fumigation treatments were applied in early October, 1994. Two row beds were shaped, fumigated (2 shanks/bed, 15-20 cm deep), and covered with tarpaulin. Transplants were planted through the plastic tarpaulin one month later. While none of the bed fumigation treatments gave the level of disease control or yield expected following broadcast fumigation with Methyl Bromide/Chloropicrin, all increased yield significantly relative to that in nonfumigated soil. The treatments in order of increasing yield were nontreated soil, Methyl Iodide/Chloropicrin (75/25% @ 360 lb/acre), Telone II/Chloropicrin (70/30% @ 425 lb/acre), Basamid (Dazomet, 400 lb/acre), Methyl Iodide (365 lb/acre), and Methyl Bromide/Chloropicrin (67/33% @ 325 lb/acre). All but the Methyl Iodide/Chloropicrin treatment reduced the incidence of plants with Verticillium wilt by approximately 50% relative to a nontreated control. Verticillium populations in soil increased during the growth of strawberries.

In a rotation experiment at Davis, CA, strawberries planted in nonfumigated soil following broccoli, strawberry, or a fallow treatment had equivalent growth and yields. Broadcast fumigation with Methyl Bromide/Chloropicrin (67/33% @ 325 lb/acre) before planting strawberries approximately doubled yields.

The bed fumigation and rotation experiments are being repeated with modifications in 1995-96. In addition, broadcast fumigation treatments were reapplied in September, 1995, to the ground treated in September, 1993, to measure longer-term and carry-over effects of the various fumigants used in the experiments on strawberries.